

METHODS AND APPARATUSES FOR BONE RESTORATION

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 11/150,676, filed on Jun. 9, 2005, which is a continuation-in-part of U.S. patent application Ser. No. 10/951,766, filed on Sep. 29, 2004, which claims priority to French patent application No. 04 06211 filed on Jun. 9, 2004, the entire disclosures of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention relates to the field of surgery and medical implants and more particularly to devices and methods for restoring human or animal bone anatomy using medical bone implants.

BACKGROUND OF THE INVENTION

Various causes can be at the root of bone compression, in particular osteoporosis which causes (for example) natural vertebral compression under the weight of the individual, but also traumas, with the two causes occasionally being combined. Such bone compressions can affect the vertebrae but also concern other bones, such as the radius and the femur, for example.

Several vertebroplasty techniques are known for effecting a vertebral correction i.e., to restore a vertebra to its original shape, or a shape similar to the latter. For example, one technique includes the introduction of an inflatable balloon into a vertebra, then introducing a fluid under pressure into the balloon in order to force the cortical shell of the vertebra, and in particular the lower and upper vertebral plateaus, to correct the shape of the vertebra under the effect of the pressure. This technique is known by as kyphoplasty. Once the osseous cortical shell has been corrected, the balloon is then deflated, and withdrawn from the vertebra in order to be able to inject a cement into the cortical shell which is intended to impart, sufficient mechanical resistance for the correction to have a significant duration in time.

A notable disadvantage of the kyphoplasty method resides in its numerous manipulations, in particular inflation, and in the necessity to withdraw the balloon from the patient's body. Furthermore, the expansion of a balloon is poorly controlled because the balloon's volume is multi-directional, which often causes a large pressure to be placed on the cortical shell in unsuitable directions. Such large pressures risk bursting of the cortical shell, and in particular, the lateral part of the cortical shell connecting the lower and upper plateaus of a vertebra.

Other vertebral implants exist which are intended to fill a cavity in a vertebra. Such implants, however, generally adopt a radial expansion principle obtained by formation of a plurality of points which stand normally to the longitudinal axis of the implant under the effect of contraction of the latter. Such implants impose too high a pressure on individual points which may pierce the material on which the points support. Furthermore, similar to kyphoplasty, very high pressure can cause bursting of the tissues or organ walls, such as the cortical shell, for example. Furthermore, the radial expansion of some implants does not allow a particular expansion direction to be favoured.

SUMMARY OF THE INVENTION

Embodiments of the present invention reduce the above noted disadvantages and provide additional advantages over the prior art devices of bone restoration. More particularly, some embodiments of the present invention include methods for restoration of human or animal bone anatomy, and include one or more of the following steps:

- introduction, into a bone for restoring, of an expandable implant according to a single determined expansion plane which is preferably intrinsic to the implant,
- positioning the expandable implant in the bone in order to make the expansion plane correspond with a bone restoration plane,
- opening out the expandable implant in the bone restoration plane, and
- injecting a filling material in an around the implant.

The method, according to some embodiments of the invention, allows the creation of a reinforced structure resulting in a solid structure (i.e., the implant incorporated by a hardened filling material thanks to the expansion of the implant). Moreover, the filling material can be injected under relatively low pressure since the implant remains in place which enables the preservation of the dimensions of the corrected bone structure.

It is another feature of an embodiment of the present invention that the expandable implant may be expanded/opened-out in the bone restoration plane to a determined value: between a minimum thickness of the implant before any expansion and a maximum thickness of the implant after maximum expansion. Such a feature allows the expansion value of the implant to be controlled, for example, for a given vertebral correction.

Another advantageous feature of an embodiment of the present invention includes the opening out of the expandable implant, by opening out first and second opposite plates, forming (respectively) first and a second support surfaces for the bone. Such a feature allows the pressure which is exerted by the implant on the tissues in contact with the latter to be reduced, by increasing the contact or support surface on the tissues.

The length of the implant may also be sized to be substantially equal to at least one of the first and second support surfaces in the bone. Such a feature allows optimization of a ratio of the support length on the tissues to the length of the implant. For example, the closer this ratio is to one, the more the implant will be usable in places requiring a small length. Moreover, this feature also allows the introduction of a filling material with low injection pressure—in one embodiment, the injection pressure is the lowest possible so as to avoid having the filling material be injected into inappropriate tissues such as blood vessel walls (for example).

In another embodiment of the invention, each of the first and second plates may form partially cylindrical support surfaces, one portion of which may be parallel to a longitudinal axis of the expandable implant.

In another embodiment of the present invention, the opening out first and second plates includes raising the latter using one or more supports under the plates. Such a feature allows a ratio of the length of the support surfaces to the length of the implant to be increased to be as close to one (1) as possible, as will be explained in more detail further on with the description of an embodiment of the invention. Furthermore, this feature allows thrust forces to be distributed under the plate in order to reduce the cantilever.

A filler cement may be injected in an around the implant, so as to aid in compressive load with the implant in bone restoration. Cements that may be used with the implants according